

pressure gradient across the walls. A commercial 500-liter storage dewar maintains a reservoir of liquid helium within a minimal (hence low mass) volume. Once a 40-km altitude is reached, the valve venting the vacuum space of the bucket dewar is closed to seal the vacuum space. A vacuum pump then evacuates the dewar vacuum space to

provide the necessary thermal isolation. Liquid helium may then be transferred from the storage dewar into the bucket dewar to cool the telescope inside the bucket dewar.

By splitting the functions of helium storage and in-flight thermal isolation, the parasitic mass associated with the dewar pressure vessel is eliminated to

achieve factor-of-five or better reduction in mass. The lower mass allows flight on conventional scientific research balloons, even for telescopes 3 to 5 meters in diameter.

*This work was done by Alan Kogut, Bryan James, and Dale Fixsen of Goddard Space Flight Center. Further information is contained in a TSP (see page 1).GSC-16687-1*

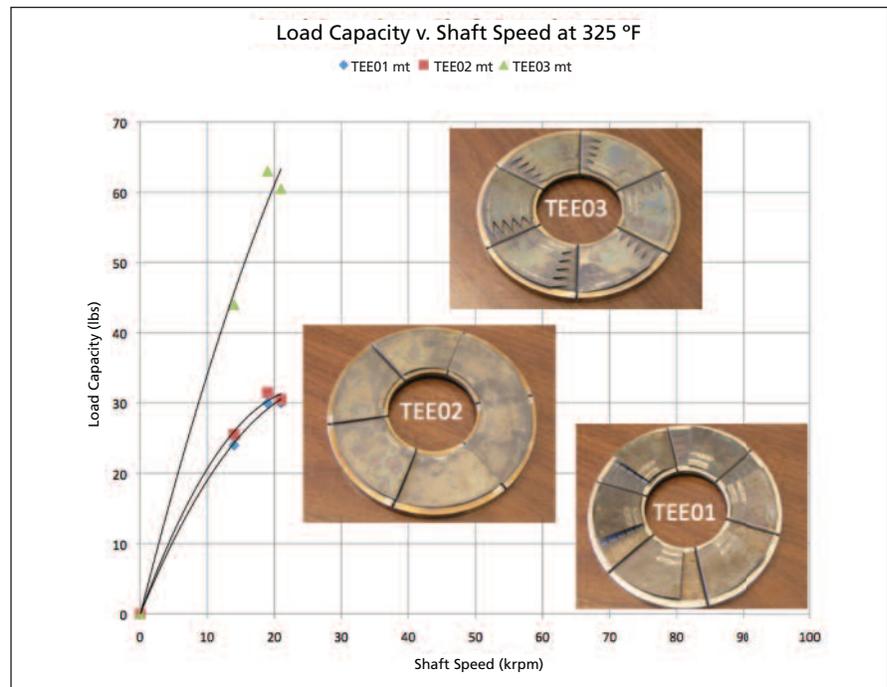
## Method to Increase Performance of Foil Bearings Through Passive Thermal Management

**Bearing load capacity is improved by multiples and reliability is enhanced.**

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This invention is a new approach to designing foil bearings to increase their load capacity and improve their reliability through passive thermal management. In the present case, the bearing is designed in such a way as to prevent the carryover of lubricant from the exit of one sector to the inlet of the ensuing sector of the foil bearing. When such passive thermal management techniques are used, bearing load capacity is improved by multiples, and reliability is enhanced when compared to current foil bearings. This concept has recently been tested and validated, and shows that load capacity performance of foil bearings can be improved by a factor of two at relatively low speeds with potentially greater relative improvements at higher speeds. Such improvements in performance with respect to speed are typical of foil bearings. Additionally, operation of these newly conceived bearings shows much more reliability and repeatable performance. This trait can be exploited in machine design to enhance safety, reliability, and overall performance. Finally, lower frictional torque has been demonstrated when operating at lower (non-load capacity) loads, thus providing another improvement above the current state of the art.

The objective of the invention is to incorporate features into a foil bearing that both enhance passive thermal management and temperature control, while at the same time improve the hydrodynamic (load capacity) performance of the foil bearing. Foil bearings are unique antifricition devices that can utilize the working fluid of a machine as a lubricant (typically air for turbines and motors, liquids for pumps), and as a coolant to remove excess energy due to frictional heating. The



Low-speed data showing the increased load capacity of the Foil Bearing Technology.

current state of the art of foil bearings utilizes forced cooling of the bearing and shaft, which represents poor efficiency and poor reliability.

This invention embodies features that utilize the bearing geometry in such a manner as to both support load and provide an inherent and passive cooling mechanism. This cooling mechanism functions in such a way as to prevent used (higher temperature) lubricant from being carried over from the exit of one sector into the entry of the next sector of the foil bearing.

The disclosed innovation is an improved foil bearing design that reduces or eliminates the need for force cooling

of the bearing, while at the same time improving the load capacity of the bearing by at least a factor of two. These improvements are due to the elimination of lubricant carryover from the trailing edge of one sector into the leading edge of the next, and the mixing of used lubricant with the surrounding ambient fluid.

*This work was done by Robert Bruckner of Glenn Research Center. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18789-1*